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1. Your reference — PPD 70048/GB/P

2. Patent application number *(The Patent Office will fill in this part)* — 0213654.7

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

SYNGENTA Limited
European Regional Centre
Priestley Road
Surrey Research Park, Guildford,
Surrey, GU2 7YH, United Kingdom

Patents ADP number *(if you know it)* — ~~6254007002~~ 8330747001

If the applicant is a corporate body, give the country/state of its incorporation — UNITED KINGDOM

4. Title of the invention

COMPOSITION

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Jane SWIFT
Intellectual Property Department
Syngenta Limited
Jealott's Hill International Research Centre
PO Box 3538
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UNITED KINGDOM

Patents ADP number *(if you know it)* — 8029506001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

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a) any applicant named in part 3 is not an inventor, or
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Description 13

Claim(s) 03

Abstract 01

Drawing(s) 00

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Priority documents

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Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*

Request for preliminary examination and search *(Patents Form 9/77)*

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11. I/We request the grant of a patent on the basis of this application.

Syngenta Limited

Signature J A Bowdich Date 13/6/02

Authorised Signatory

12. Name and daytime telephone number of person to contact in the United Kingdom

Julie Anne BOWDICH = 01344 414102

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COMPOSITION

The present invention relates to a herbicidal composition, to its preparation and use.

The protection of crops from weeds and other vegetation that inhibits crop growth is a constantly recurring problem in agriculture. To help combat this problem, researchers in the field of synthetic chemistry have produced an extensive variety of chemicals and chemical formulations effective in the control of such unwanted growth. Chemical herbicides of many types have been disclosed in the literature and a large number are in commercial use. Commercial herbicides and some that are still in development are described in The Pesticide Manual, 12th edition, published in 2000 by the British Crop Protection Council.

Many herbicides also damage crop plants. The control of weeds in a growing crop therefore requires the use of so-called 'selective' herbicides which are chosen to kill the weeds while leaving the crop undamaged. Few selective herbicides are selective enough to kill all the weeds and leave the crop completely untouched. In practice, the use of most selective herbicides is actually a balance between applying enough herbicide to acceptably control most of the weeds whilst causing only minimal crop damage.

One important class of selective herbicides are 2-(substituted benzoyl)-1,3-cyclohexanedione compounds disclosed, *inter alia*, in United States Patent Nos. 4,780,127, 4,938,796, 5,006,158 and 5,089,046 the disclosures of which are incorporated herein by reference. A particularly preferred 2-(substituted benzoyl)-1,3-cyclohexanedione is mesotrione, chemical name 2-(2-nitro-4-methylsulfonylbenzoyl)-cyclohexanedione. This is known largely for use to selectively control weeds in a corn (maize) crop, both before the crop emerges from the ground (pre-emergent) and after (post-emergent).

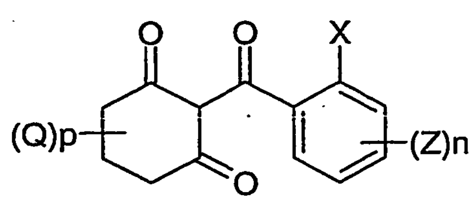
One preferred form of mesotrione is as a metal salt or chelate, for example a copper salt. These metal chelates are disclosed in US 5 912 207 where they are shown to have unexpectedly superior stability in water compared to unchelated mesotrione. WO 01/095722 discloses that metal chelates of 2-(substituted benzoyl)-1,3-cyclohexanedione compounds can have improved selectivity over the unchelated compounds.

One problem with the metal chelates of 2-(substituted benzoyl)-1,3-cyclohexanedione is that their overall activity is lower than that of the parent compound itself. We have discovered that by adding an organic phosphate, phosphonate or phosphinate adjuvant to the metal chelate, we can produce mesotrione metal chelate compositions with a combination of an unexpectedly high level of activity with little or no damage to a crop in comparison to non-chelated mesotrione acid formulations. The low level of crop damage in this way is often referred to as 'safening'. This surprising improvement in activity and safening enables mesotrione to be used more effectively and with less risk of crop damage.

Bis (2-ethylhexyl) 2-ethylhexyl phosphonate has been suggested for use as an agrochemical adjuvant. For example, US 2 927 014 discloses the use of a range of organic phosphonate and phosphinate compounds as herbicides. WO93/04585 discloses the use of certain organic phosphinate and phosphonate compounds as adjuvants to enhance the activity of certain herbicides. WO94/18837 teaches the use of a specific phosphonate, bis (2-ethyl hexyl) 2-ethylhexyl phosphonate, as adjuvant to improve the bioperformance of specified of herbicides. In WO98/00021 there is disclosed that certain phosphonate or phosphinate compounds provide improved fungicidal activity in combination with certain fungicides such as fluquinconazole and azoxystrobin. However, the particular use of phosphonate and phosphinate in improving the efficacy and selectivity of 2-(substituted benzoyl)-1,3-cyclohexanedione **metal** chelates is wholly unexpected.

Accordingly, the present invention provides a herbicidal composition comprising:

i) a metal chelate of a 2-(substituted benzoyl)-1,3-cyclohexanedione of formula (I)



(I)

wherein X represents a halogen atom; a straight- or branched-chain alkyl or alkoxy group containing up to six carbon atoms which is optionally substituted by one or more groups $-OR^1$ or one or more halogen atoms; or a group selected from nitro, cyano, $-CO_2R^2$, $-S(O)_mR^1$, $-O(CH_2)_rOR^1$, $-COR^2$, $-NR^2R^3$, $-SO_2NR_2R^3$, $-CONR^2R^3$, $-CSNR^2R^3$ and $-OSO_2R_4$;

R^1 represents a straight- or branched-chain alkyl group containing up to six carbon atoms which is optionally substituted by one or more halogen atoms;

R^2 and R^3 each independently represents a hydrogen atom; or a straight- or branched-chain alkyl group containing up to six carbon atoms which is optionally substituted by one or more halogen atoms;

R^4 represents a straight-or branched-chain alkyl, alkenyl or alkynyl group containing up to six carbon atoms optionally substituted by one or more halogen atoms; or a cycloalkyl group containing from three to six carbon atoms;

each Z independently represents halo, nitro, cyano, $S(O)_mR^5$, $OS(O)_mR^5$, $(C_1$-$C_6)$-alkyl, $(C_1$-$C_6)$alkoxy, $(C_1$-$C_6)$haloalkyl, $(C_1$-$C_6)$haloalkoxy, carboxy, $(C_1$-$C_6)$-alkylcarbonyloxy, $(C_1$-$C_6)$alkoxycarbonyl, $(C_1$-$C_6)$alkylcarbonyl, amino, $(C_1$-$C_6)$-alkylamino, $(C_1$-$C_6)$dialkylamino having independently the stated number of carbon atoms in each alkyl group, $(C_1$-$C_6)$alkylcarbonylamino, $(C_1$-$C_6)$alkoxycarbonylamino, $(C_1$-$C_6)$alkylaminocarbonylamino, $(C_1$-$C_6)$dialkylaminocarbonylamino having independently the stated number of carbon atoms in each alkyl group, $(C_1$-$C_6)$-alkoxycarbonyloxy, $(C_1$-$C_6)$alkylaminocarbonyloxy, $(C_1$-$C_6)$dialkylcarbonyloxy, phenylcarbonyl, substituted phenylcarbonyl, phenylcarbonyloxy, substituted phenylcarbonyloxy, phenylcarbonylamino, substituted phenylcarbonylamino, phenoxy or substituted phenoxy;

R^5 represents cyano, $-COR^6$, $-CO_2R^6$ or $-S(O)_mR^7$;

R^6 represents hydrogen or straight- or branched-chain alkyl group containing up to six carbon atoms;

R^7 represents $(C_1$-$C_6)$alkyl, $(C_1$-$C_6)$haloalkyl, $(C_1$-$C_6)$cyanoalkyl, $(C_3$-$C_8)$cycloalkyl optionally substituted with halogen, cyano or $(C_1$-$C_4)$alkyl; or phenyl optionally substituted with one to three of the same or different halogen, nitro, cyano, $(C_1$-$C_4)$haloalkyl, $(C_1$-$C_4)$alkyl, $(C_1$-$C_4)$alkoxy or $-S(O)_mR^8$;

R^8 represents $(C_1$-$C_4)$alkyl;

each Q independently represents $(C_1$-$C_4)$alkyl or $-CO_2R^9$ wherein R^9 is $(C_1$-$C_4)$alkyl;

m is zero, one or two;

n is zero or an integer from one to four;

r is one, two or three; and

p is zero or an integer from one to six; and

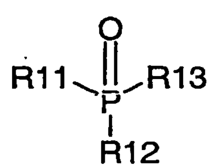
ii) an organic phosphate, phosphonate or phosphinate adjuvant.

Suitably, X is chloro, bromo, nitro, cyano, C_1-C_4 alkyl, $-CF_3$, $-S(O)_mR^1$, or $-OR^1$; each Z is independently chloro, bromo, nitro, cyano, C_1-C_4 alkyl, $-CF_3$, $-OR^1$, $-OS(O)_mR^5$ or $-S(O)_mR^5$; n is one or two; and p is zero.

Preferably, the 2-(substituted benzoyl)-1,3-cyclohexanedione of formula (I) is selected from the group consisting of 2-(2'nitro-4'methylsulphonylbenzoyl)-1,3-cyclohexanedione, 2-(2'-nitro-4'-methylsulphonyloxybenzoyl)-1,3-cyclohexanedione, 2-(2'-chloro-4'-methylsulphonylbenzoyl)-1,3-cyclohexanedione, 4,4-dimethyl-2-(4-methanesulphonyl-2-nitrobenzoyl)-1,3-cyclohexanedione, 2-(2-chloro-3-ethoxy-4-methanesulphonylbenzoyl)-5-methyl-1,3-cyclohexanedione and 2-(2-chloro-3-ethoxy-4-ethanesulphonylbenzoyl)-5-methyl-1,3-cyclohexanedione.

The metal ion forming the chelate is suitably a di- or trivalent metal ion such as, but not restricted to, Cu^{+2}, Co^{+2}, Zn^{+2}, Ni^{+2}, Ca^{+2}, Al^{+3}, Ti^{+3} and Fe^{+3}. The preferred metal ions are divalent transition metal ions, particularly Cu^{+2}, Ni^{+2}, Zn^{+2} and Co^{+2}, with Cu^{+2} being especially preferred. Any appropriate salt that would be a source of a di- or trivalent metal ion may be used to form the metal chelate of the 2-(substituted benzoyl)-1,3-cyclohexanedione of formula (I) in accordance with this invention. Particularly suitable salts include: chlorides, sulphates, nitrates, carbonates, phosphates and acetates.

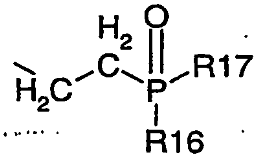
Suitably, the phosphate, phosphonate or phosphinate adjuvant is a compound of formula II



(II)

wherein R^{11} is an alkoxy group containing from 4 to 20 carbon atoms or a group $-[OCH_2CHR^{14}]_t-OR^{15}$ wherein R^{14} is hydrogen, methyl or ethyl, t is from 0 to 50 and R^{15} is hydrogen or an alkyl group containing from 1 to 20 carbon atoms; and R^{12} and R^{13} are independently (i) an alkyl or alkenyl group containing from 4 to 20 carbon atoms; (ii)

optionally substituted phenyl; (iii) an alkoxy group containing from 4 to 20 carbon atoms or (iv) a group $-[OCH_2CHR^{14}]_t-OR^{15}$ as herein defined; or (v) a group of formula (III)



(III)

wherein R^{16} is an alkoxy group containing from 4 to 20 carbon atoms or a group $-[OCH_2CHR^{14}]_t-OR^{15}$ as herein defined and R^{17} is an alkyl group containing from 4 to 20 carbon atoms, optionally substituted phenyl, an alkoxy group containing from 4 to 20 carbon atoms or a group $-[OCH_2CHR^{14}]_t-OR^{15}$ as herein defined; and wherein t is from 0 to ten.

The term "alkyl" as used herein, including when used in expressions such as "alkoxy", includes linear or branched chain alkyl groups. Optional substituents which may be present in optionally substituted phenyl include C_{1-4} alkyl and halogen.

When all of R^{11}, R^{12} and R^{13} are alkoxy groups, the compound of formula (II) is an organic phosphate. When R^{11} and R^{12} are alkoxy groups and R^{13} is an alkyl, alkenyl or optionally substituted phenyl group, the compound of formula (II) is an organic phosphonate. When R^{11} is an alkoxy group and R^{12} and R^{13} are alkyl, alkenyl or optionally substituted phenyl groups, the compound of formula (II) is an organic phosphinate.

Optional alkoxylation of an ester group is represented by the group $-[OCH_2CHR^{14}]_t-OR^{15}$ as herein defined. It is preferred that the value of t is from 0 to 10 and more preferably from 0 to 5. If a range of degrees of alkoxylation is present, t may represent an average value and is not necessarily an integer. Similarly, mixed alkoxylation may take place such that different values of R^{14} are present in the group $-[OCH_2CHR^{14}]_t$. It is preferred that R^{15} is an alkyl group containing from 1 to 8 carbon atoms. If t is 0, the group $-[OCH_2CHR^{14}]_t-OR^{15}$ becomes alkoxy and when t is 0 therefore the group $-OR^{15}$ is suitably alkoxy containing from 4 to 20 carbon atoms.

When the compound of formula (II) is a phosphonate, it is preferred that each of the groups R^{11} and R^{12} are alkoxy groups containing from 4 to 10 carbon atoms and R^{13} is an alkyl group containing from 4 to 10 carbon atoms. Suitable phosphonates are disclosed in WO 98/00021 and the present invention also includes equivalents wherein the relevant alkyl chain length is lower than that disclosed in WO 98/00021. It is especially preferred that each of R^{11}, R^{12} and R^{13} contain from 4 to 8 carbon atoms.

Preferred phosphonates are bis-(2-ethylhexyl)-2-ethylhexylphosphonate, bis-(2-ethylhexyl-octylphosphonate and bis-butyl-butylphosphonate.

When the compound of formula (II) is a phosphate it is preferred that each of the groups R^{11}, R^{12} and R^{13} are alkoxy groups containing from 4 to 10 carbon atoms. It is especially preferred that each of R^{11}, R^{12} and R^{13} contain from 4 to 8 carbon atoms. Preferred phosphates are tri-2-ethylhexylphosphate and tributyl phosphate.

When the compound of formula (II) is a phosphinate, it is preferred that R^{11} is an alkoxy group containing from 4 to 10 carbon atoms and R^{12} and R^{13} are both alkyl groups containing from 4 to 10 carbon atoms. It is especially preferred that each of R^{11}, R^{12} and R^{13} contain from 4 to 8 carbon atoms. Suitable phosphonates are disclosed in WO 98/00021 and the present invention also includes equivalents wherein the relevant alkyl chain length is lower than that disclosed in WO 98/00021.

Herbicide compositions, such as those of the present invention are usually supplied as a concentrate which is diluted with, dissolved in or dispersed in water shortly before use. In the present invention, the concentrate generally comprises between 30 and 950g/litre of the 2-(substituted benzoyl)-1,3-cyclohexanedione of formula (I), preferably 100 to 800g/l., most preferably 150 to 500g/l. The phosphate, phosphonate or phosphinate adjuvant may, if desired, be added to the concentrate composition at a weight ratio of the herbicide to the phosphate, phosphonate or phosphinate of from 25:1 and 1:25 and especially 10:1 and 1:10 more especially 1:5 and 5:1. In addition, one or more further active ingredients, for example a second herbicide, may be added to the concentrate composition.

Alternatively, the phosphate, phosphonate or phosphinate adjuvant may be added to the spray tank (diluted) composition. Adjuvants are normally applied as a percentage of the spray volume applied per hectare. Water volume per hectare is normally about 200 litres/ha but can vary from 50 to greater than 3000 for special applications. Adjuvants are nominally applied at volumes of from 0.05% to 1.0% of the spray volume per hectare. Taking 200 l/ha as an average, typical volume rates of adjuvant will therefore be in the region of 100g (0.05%) to 2000g (1.0%). Typical herbicide rates range from 10g/ha to 1kg. Therefore one skilled in the art will expect ratios which cover these typical use rates for both active and adjuvant. These relate directly to ratio (by weight) of compound of formula (I) to the compound of formula (II) from 50:1 to 1:400. It is preferred that the ratio by weight of the compound of formula (I) to the compound of

formula (II) is from 25:1 and 1:25 and especially 10:1 and 1:10 more especially 1:5 and 5:1.

The herbicidal composition of the invention may thus be formulated as granules, as wettable powders, as suspension concentrates, as emulsifiable concentrates, as granular formulations, powders or dusts, as flowables, as solutions, as suspensions or emulsions. These formulations may contain as little as about 0.5% to as much as about 95% or more by weight of active ingredient. The optimum amount for any given compound will depend upon formulation, application equipment, and nature of the plants to be controlled.

Wettable powders are in the form of finely divided particles that disperse readily in water or other liquid carriers. The particles contain the active ingredient retained in a solid matrix. Typical solid matrices include fuller's earth, kaolin clays, silicas and other readily wet organic or inorganic solids. Wettable powders normally contain about 5% to about 95% of the active ingredient plus a small amount of wetting, dispersing, or emulsifying agent. If liquid compounds of Formula II are formulated as dry products such as WP (or WG), there will be a requirement to absorb/adsorb these into/onto suitable carriers for this formulation type.

Suspension concentrates are high concentration suspensions of solid herbicide in a liquid carrier such as water or an oil.

Emulsifiable concentrates are homogeneous liquid compositions dispersible in water or other liquid, and may consist entirely of the active compound with a liquid or solid emulsifying agent, or may also contain a liquid carrier, such as xylene, heavy aromatic naphthas, isophorone and other non-volatile organic solvents. In use, these concentrates are dispersed in water or other liquid and normally applied as a spray to the area to be treated. The amount of active ingredient may range from about 0.5% to about 95% of the concentrate.

Granular formulations include both extrudates and relatively coarse particles, and are usually applied without dilution to the area in which suppression of vegetation is desired. Typical carriers for granular formulations include sand, fuller's earth, attapulgite clay, bentonite clays, montmorillonite clay, vermiculite, perlite and other organic or inorganic materials which absorb or which can be coated with the active compound.

Granular formulations normally contain about 5% to about 25% active ingredients which may include surface-active agents such as heavy aromatic naphthas, kerosene and other petroleum fractions, or vegetable oils; and/or stickers such as dextrins, glue or synthetic resins. Water emulsifiable granules can also be produced by appropriate means which are well know to those skilled in the art.

Dusts are free-flowing admixtures of the active ingredient with finely divided solids such as talc, clays, flours and other organic and inorganic solids that act as dispersants and carriers.

Formulations which are amenable to the production of mixed products are especially important since a compound of formula II will generally be an oil (or soluble in an organic solvent) and the 2-(substituted benzoyl)-1,3-cyclohexanedione derivatives of formula (I) will generally be highly insoluble in water and therefore most easily formulated as a dispersion in water (or an oil). Thus dispersions of multiple phases are the likely formulations of choice.

Other useful formulations for herbicidal applications include simple solutions of the active ingredient in a solvent in which it is completely soluble at the desired concentration, such as acetone, alkylated naphthalenes, xylene and other organic solvents. Pressurized sprayers, wherein the active ingredient is dispersed in finely divided form as a result of vaporization of a low boiling dispersant solvent carrier, may also be used.

Many of these formulations include wetting, dispersing or emulsifying agents. Examples are alkyl and alkylaryl sulphonates and sulphates and their salts; polyhydric alcohols; polyethoxylated alcohols; esters and fatty amines. These agents, when used, normally comprise from 0.1% to 15% by weight of the formulation.

Another suitable additive is crop oil concentrate (COC) which is well known for herbicides and is a mixtures of petroleum oils and non-ionic surfactants, available as, for example AGRI-DEX, PENETRATOR, and PENETRATOR PLUS and from Helena Chemical Company, HER-BIMAX from UAP, ES CROP OIL PLUS from Gromark, and CROP OIL PLUS, from Wilfarm, (83% parafinic oil, 17% emulsifier surfactant). Other possible additives include urea ammonium nitrate, a fertiliser, methylated seed oil and ammonium sulphate.

Each of the above formulations can be prepared as a package containing the herbicide together with other ingredients of the formulation (other active ingredients, diluents, emulsifiers, surfactants, etc.). The formulations can also be prepared by a tank mix method, in which the ingredients are obtained separately and combined at the grower site.

The compositions of the present invention can be used to control the growth of weeds. Accordingly, a further aspect of the invention provides a process for the control of weeds, said process comprising applying a herbicidally effective amount of a composition according to the invention to the locus of the weeds.

The composition of the invention may be used against a large number of agronomically important weeds, including Stellaria, Nasturtium, Agrostis, Digitaria, Avena, Setaria, Sinapis, Lolium, Solanum, Phaseolus, Echinochloa, Scirpus, Monochoria, Sagittaria, Bromus, Alopecurus, Sorghum halepense, Rottboellia, Cyperus, Abutilon, Sida, Xanthium, Amaranthus, Chenopodium, Ipomoea, Chrysanthemum, Galium, Viola, and Veronica. For purposes of the present invention, the term "weeds" includes undesirable crop species such as volunteer crops.

Controlling means killing, damaging, or inhibiting the growth of the weeds.

The "locus" is intended to include soil, seeds, and seedlings, as well as established vegetation.

The benefits of the present invention are seen most when the composition is applied to kill weeds in a growing crop, such as Maize (corn). The benefit of the invention is seen most with post-emergent application, but pre-emergent application is also possible.

The present invention is illustrated by the following Example in which all parts and percentages are by weight unless otherwise stated.

EXAMPLE 1

The efficacy of the copper salt of mesotrione was compared against a Suspension Concentrate (SC) formulation of mesotrione acid in combination with a methylated seed oil (MSO) adjuvant (at 0.5%v/v of spray volume) giving a typical control spectrum across a weed spectrum. An improved tank mix composition with added UAN (Urea-ammonium nitrate) with MSO demonstrated higher (commercial) levels of control

against weeds but showed significant phytotoxicity on crops (up to 13% damage). A 35% w/w SC of Cu mesotrione was employed with which a number of adjuvants (including those of formula II) were tank mixed. The weeds were *Echinochloa crus-galli* (ECHCG), *Brachiaria platphylla* (BRAPL), *Amaranthus tamariscinus* (AMATA), *Ipomoea hederacea* (IPOHE), *polygonum convolvulus* (POLCO) and *Xanthium strumarium*, (XANST), and two maize varieties (for crop damage assessment) were ZEAMX 'FURIO', ZEAMX 'MARISTA'. Products were sprayed at a range of g/ha (see table) in 200l/ha water volume and assessed after 21 days for bioefficacy.

Cu Mesotrione as an SC formulation was not used in the study because its activity level is lower than the acid formulation.

Results are listed below in Table 1:

These results indicate the considerable improvement in bioefficacy of the normally poorly active Cu mesotrione salt when mixed with a compound of formula II coupled with the significant reduction in phytotoxicty compared to the MSO + UAN treatment.

Table 1:

Treatment	Rate mesotrione g/ha	ZEAMX 'FURIO'	ZEAMX 'MARISTA'	ECHCG	XANST	AMARE	IPOHE	POLCO
Mesotrione acid + MSO 0.5%	10				84	52.5	57.5	55
	20			12.5	91.5	57.5	77.5	66.5
	40			70	91.5	87.5	82.5	84
	80			75	96	90	76.5	95
	160	0	0	96.5	97.5	88.5	80	96
	320	0	0	98.5				
Mesotrione acid + MSO 0.5% + UAN 0.5%	10				90	80	75	92.5
	20			72.5	96.5	86.5	72.5	90.5
	40			90	97.5	80	72.5	98.5
	80			96.5	96.5	93	77.5	97.5
	160	13	3	98	98	97.5	85	99
	320	12	8	98.5				
Mesotrione copper salt + tributylphosphate 0.5%	10				98	85	82.5	98.5
	20			30	93	84	80	92
	40			30	97.5	96.5	89	80
	80			64	96	90	82.5	98.5
	160	0	2	97	98	97.5	90	99
	320	0	0	96.5				
Mesotrione copper salt + dibutyl butyl phosphonate 0.5%	10				99	99	92.5	99.5
	20			72.5	99.5	97.5	90	100
	40			98	98.5	99.5	95	95
	80			98	99	99.5	96.5	99.5
	160	7	5	99.5	99.5	100	96.5	100
	320	5	3	100				

EXAMPLE 2

The efficacy of the copper salt of mesotrione was compared with a suspension concentrate (SC) formulation of mesotrione acid with a methylated seed oil (MSO) adjuvant (at 0.5%v/v of spray volume) giving a typical control spectrum across a weed spectrum. A 35% w/w SC of Cu mesotrione was employed with which a number of adjuvants (including those of formula II)were tank mixed. The weeds were, *Ipoemoea hereracea* (IPOHE), *Polygonum convolvulus* (POLCO), *Xanthium strumarium* (XANST) and *Echinochloa crus-galli* (ECHCG) and three maize varieties (for crop damage assessment) were ZEAMX 'FURIO', ZEAMX 'MARISTA' and ZEAMX 'BANGUY'. Products were sprayed at a range of g ai/ha (see tables) in 200l/ha water volume and assessed after 21 days for bioefficacy.

Cu Mesotrione as an SC ~~formulation alone was not used in the study because its~~ activity level is lower than the acid formulation.

Results are listed below in Table 2:

These results indicate the considerable improvement in bioefficacy of the normally poorly active Cu mesotrione chelate when mixed with a compound of formula II coupled with the significant reduction in phytotoxicty compared to the MSO + UAN treatment.

Table 2: Weed control (%)

TREATMENT	Rate g/ha Mesotrione	IPOHE	POLCO	XANST	ECHCG
Mesotrione acid + 0.5% MSO	10	33	35	58	
	20	68	48	55	23
	40	76	71	75	25
	80	70	80	80	50
	160	75	96	78	63
Mesotrione Acid + 0.5% MSO + 0.5% UAN	10	73	70	75	
	20	73	83	84	53
	40	80	94	85	73
	80	89	93	83	78
	160	89	98	86	80
Mesotrione copper salt + 0.5% di butyl butyl phosphonate	10	70	97	91	
	20	68	83	90	20
	40	84	98	89	40
	80	88	98	93	38
	160	74	98	87	35
Mesotrione copper salt + 0.5% bis(2-ethylhexyl) 2-ethylhexyl phosphonate	10	88	88	95	
	20	88	82	95	60
	40	86	97	90	68
	80	93	98	90	78
	160	96	98	92	99
Mesotrione copper salt + 0.5% bis(2-ethylhexyl) 1-octylphosphonate	10	80	69	95	
	20	80	69	80	35
	40	86	94	89	43
	80	91	96	90	55
	160	93	98	90	60

Further to the significant enhancement in the activity in the copper salt, as shown in Table 2, the assessments of phytotoxicity in Table 3 indicate that the copper salt in combination with the phosphonates is also plant safe to a selection of maize varieties, unlike the acid form of mesotrione.

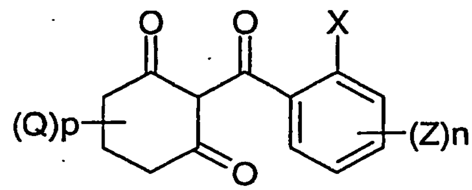
Table 3: Phytotoxicity to three maize varieties 7 d after application

Adjuvant treatment	Rate g/ha mesotrione	Mesotrione acid			Mesotrione copper salt		
		ZEAMX 'BANGUY'	ZEAMX 'FURIO'	ZEAMX 'MARISTA'	ZEAMX 'BANGUY'	ZEAMX 'FURIO'	ZEAMX 'MARISTA'
0.5% Di butyl butyl phosphonate	10						
	20						
	40						
	80						
	160	1	2	5	6	3	1
0.5% Bis(2-ethylhexyl)2-ethylhexyl phosphonate	10						
	20						
	40						
	80						
	160	40	30	20	3	4	4
0.5% Bis(2-ethylhexyl)1-octyl phosphonate	10						
	20						
	40						
	80						
	160	23	7	3	1	0	1

CLAIMS

1. A herbicidal composition comprising:

(i) a metal chelate of a 2-(substituted benzoyl)-1,3-cyclohexanedione of formula (I)



(I)

wherein X represents a halogen atom; a straight- or branched-chain alkyl or alkoxy group containing up to six carbon atoms which is optionally substituted by one or more groups $-OR^1$ or one or more halogen atoms; or a group selected from nitro, cyano, $-CO_2R^2$, $-S(O)_mR^1$, $-O(CH_2)_rOR^1$, $-COR^2$, $-NR^2R^3$, $-SO_2NR_2R^3$, $-CONR^2R^3$, $-CSNR^2R^3$ and $-OSO_2R_4$;

R^1 represents a straight- or branched-chain alkyl group containing up to six carbon atoms which is optionally substituted by one or more halogen atoms;

R^2 and R^3 each independently represents a hydrogen atom; or a straight- or branched-chain alkyl group containing up to six carbon atoms which is optionally substituted by one or more halogen atoms;

R^4 represents a straight-or branched-chain alkyl, alkenyl or alkynyl group containing up to six carbon atoms optionally substituted by one or more halogen atoms; or a cycloalkyl group containing from three to six carbon atoms;

each Z independently represents halo, nitro, cyano, $S(O)_mR^5$, $OS(O)_mR^5$,

(C_1-C_6)alkyl, (C_1-C_6)alkoxy, (C_1-C_6)haloalkyl, (C_1-C_6)haloalkoxy, carboxy,

(C_1-C_6)alkylcarbonyloxy, (C_1-C_6)alkoxycarbonyl, (C_1-C_6)alkylcarbonyl, amino, (C_1-C_6)alkylamino, (C_1-C_6)dialkylamino having independently the stated number of carbon atoms in each alkyl group, (C_1-C_6)alkylcarbonylamino,

(C_1-C_6)alkoxycarbonylamino, (C_1-C_6)alkylaminocarbonylamino,

(C_1-C_6)dialkylaminocarbonylamino having independently the stated number of carbon atoms in each alkyl group, (C_1-C_6)alkoxycarbonyloxy,

$(C_1\text{-}C_6)$alkylaminocarbonyloxy, $(C_1\text{-}C_6)$dialkylcarbonyloxy, phenylcarbonyl, substituted phenylcarbonyl, phenylcarbonyloxy, substituted phenylcarbonyloxy, phenylcarbonylamino, substituted phenylcarbonylamino, phenoxy or substituted phenoxy;

R^5 represents cyano, $-COR^6$; $-CO_2R^6$ or $-S(O)_mR^7$;

R^6 represents hydrogen or straight- or branched-chain alkyl group containing up to six carbon atoms;

R^7 represents $(C_1\text{-}C_6)$alkyl, $(C_1\text{-}C_6)$haloalkyl, $(C_1\text{-}C_6)$cyanoalkyl,

$(C_3\text{-}C_8)$cycloalkyl optionally substituted with halogen, cyano or $(C_1\text{-}C_4)$alkyl; or phenyl optionally substituted with one to three of the same or different halogen, nitro, cyano, $(C_1\text{-}C_4)$haloalkyl, $(C_1\text{-}C_4)$alkyl, $(C_1\text{-}C_4)$alkoxy or $-S(O)_mR^8$;

R^8 represents $(C_1\text{-}C_4)$alkyl;

each Q independently represents $(C_1\text{-}C_4)$alkyl or $-CO_2R^9$ wherein R^9 is

$(C_1\text{-}C_4)$alkyl;

m is zero, one or two;

n is zero or an integer from one to four;

r is one, two or three; and

p is zero or an integer from one to six; and

(ii) an organic phosphate, phosphonate or phosphinate adjuvant.

2. A herbicidal composition according to claim 1, wherein X is chloro, bromo, nitro, cyano, $C_1\text{-}C_4$ alkyl, $-CF_3$, $-S(O)_mR^1$, or $-OR^1$.

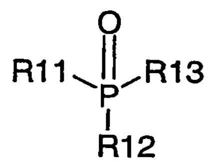
3. A herbicidal composition according to any one or claims 1 or 2, wherein each Z is independently chloro, bromo, nitro, cyano, $C_1\text{-}C_4$ alkyl, $-CF_3$, $-OR^1$, $-OS(O)_mR^5$ or $-S(O)_mR^5$.

4. A herbicidal composition according to any one of claims 1 to 3, wherein n is one or two.

5. A herbicidal composition according to any one of claims 1 to 4, wherein p is zero.

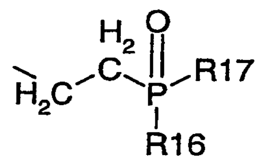
6. A herbicidal composition according to any one of claims 1 to 5, wherein the compound of formula (I) is selected from the group consisting of 2-(2'nitro-4'methylsulphonylbenzoyl)-1,3-cyclohexanedione, 2-(2'-nitro-4'-methylsulphonyloxy benzoyl)-1,3-cyclohexanedione, 2-(2'-chloro-4'-methylsulphonylbenzoyl)-1,3-cyclohexanedione, 4,4-dimethyl-2-(4-methanesulphonyl-2-nitrobenzoyl)-1,3-cyclohexanedione, 2-(2-chloro-3-ethoxy-4-methanesulphonylbenzoyl)-5-methyl-1,3-cyclohexanedione and 2-(2-chloro-3-ethoxy-4-ethanesulphonylbenzoyl)-5-methyl-1,3-cyclohexanedione.

7. A herbicidal composition according to any one of claims 1 to 6, wherein the phosphate, phosphonate or phosphinate adjuvant is a compound of formula II



(II)

wherein R^{11} is an alkoxy group containing from 4 to 20 carbon atoms or a group $-[OCH_2CHR^{14}]_t-OR^{15}$ wherein R^{14} is hydrogen, methyl or ethyl, t is from 0 to 50 and R^{15} is hydrogen or an alkyl group containing from 1 to 20 carbon atoms; and R^{12} and R^{13} are independently (i) an alkyl or alkenyl group containing from 4 to 20 carbon atoms; (ii) optionally substituted phenyl; (iii) an alkoxy group containing from 4 to 20 carbon atoms or (iv) a group $-[OCH_2CHR^{14}]_t-OR^{15}$ as herein defined; or (v) a group of formula (III)



(III)

wherein R^{16} is an alkoxy group containing from 4 to 20 carbon atoms or a group $-[OCH_2CHR^{14}]_t-OR^{15}$ as herein defined and R^{17} is an alkyl group containing from 4 to 20 carbon atoms, optionally substituted phenyl, an alkoxy group containing from 4 to 20 carbon atoms or a group $-[OCH_2CHR^{14}]_t-OR^{15}$ as herein defined; and wherein t is from 0 to ten.

8. A process for the control of weeds, said process comprising applying a herbicidally effective amount of a composition according to the invention to the locus of the weeds.

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ABSTRACT

COMPOSITION

A novel herbicidal composition comprising a metal chelate of a 2-(substituted benzoyl)-1,3-cyclohexanedione and an organic phosphate, phosphonate or phosphinate adjuvant is disclosed.